Economics of Transportation ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

Economics of Transportation

journal homepage: www.elsevier.com/locate/ecotra

Government and company contracts: The effect on service and prices in international airline markets

Nicole Adler [a], Benny Mantin [b,*]

[a] School of Business Administration, Hebrew University of Jerusalem, Mount Scopus 91905, Israel
[b] Department of Management Sciences, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1

ARTICLE INFO

Article history:
Received 2 September 2014
Received in revised form
30 April 2015
Accepted 20 May 2015

Keywords:
International airline market
Horizontal contracts
Codesharing
Government agreements
Bilaterals
Antitrust regulation

ABSTRACT

This paper provides evidence of the impacts of the level of liberalization signed between governments and the type of codeshare agreement signed between airlines in international aviation markets. Our work distils two basic insights: (i) increasing the level of liberalization has a positive effect on service and overshadows the impact of codeshares; (ii) codeshare agreements are heterogeneous in the sense that pooling and royalty agreements generally result in higher airfares whereas block and free sale codeshares are generally associated with lower airfares, although the latter has the most significant impact. Additionally, none of the codeshare agreements impact market frequency. Our results suggest that reducing regulation in the international aviation markets is likely to increase service levels, and that carve outs on non-stop links is unnecessary, rather restrictions should be imposed on horizontal contracts such as the type of codeshare agreement signed by airlines.

1. Introduction

Codesharing agreements were originally developed by airlines in the 1980s as a means to increase visibility in the global distribution systems used by travel agents. Historically, these systems provide preferential treatment to connecting flights that involved online connections (i.e., both segments of the routes are operated by the same airline) over interlining connections (i.e., involving different operating carriers). Codesharing permitted airlines to bypass this hurdle and present such flights as if they were online flights.

The term codesharing was first coined by American Airlines and Qantas in their agreement signed in 1989. Since its inception, the codesharing concept and its application have evolved dramatically. Today, airlines code share flights in a variety of configurations: parallel/unilateral on a trunk route or behind and beyond route. Under parallel operations, both airlines operate flights in the same segment (Oum et al., 1996). Under unilateral operations, only one carrier operates a flight in the relevant segment. Interestingly, a flight under unilateral agreement may not necessarily connect to the marketing airline's network. Under behind and beyond routes, the two airlines interline their flights which enables seamless connections of two (or more) flights operated by different airlines. This form of partnership between airlines adheres to the classic notion of airline codeshares.[1]

Parallel and unilateral operations of flights are of particular interest as they give rise to virtual codesharing (Ito and Lee, 2007). Under virtual codesharing, the marketing carrier does not operate any of the segments of the itinerary. One of the foci of our research is the effect of virtual codesharing agreements in international non-stop routes. Importantly, while the literature on codeshare agreements (and airline alliances) has been growing steadily over the years, it has thus far been silent on the effect of *different* codeshare agreements. Codeshare agreements can differ substantially based on the type of collaboration and trading they entail, and can be categorized into five broad groups: hard block, soft block, free sale, pooling and royalties.[2]

The type of codesharing agreements signed between airlines is of importance to policy makers and regulators particularly in international markets—which types shall be approved and which shall be prohibited—as they may affect the competitive environment but may also benefit consumers. After the law was changed

* Corresponding author. Tel.: +1 519 888 4567x32235.
E-mail addresses: msnic@huji.ac.il (N. Adler), bmantin@uwaterloo.ca (B. Mantin).

http://dx.doi.org/10.1016/j.ecotra.2015.05.005
2212-0122/

[1] Even in the absence of a codesharing agreement, (traditional) interlining can still be facilitated through other special and industry-wide agreements. The International Air Transport Association sets the industry standards and rules on interlining of flights not covered under codesharing agreements through the Multilateral Interline Traffic Agreement. Interlining, however, requires additional agreements between airlines to guarantee acceptance of ticketing which are generally facilitated via Special Prorate Agreements (SPAs).

[2] We elaborate and explain the different types in Section 2.

in Israel in 2009, the Israeli Antitrust Authority (IAA) was faced with this challenge exactly.[3] Accordingly, the IAA reviewed all codeshare agreements that local carriers had signed freely with a variety of foreign airlines, all of which except for one were of the virtual codeshare variety. After assessing the different codeshare contracts and their impact on competition, the IAA chose to cancel six codeshare exemptions, the airlines themselves canceled four, one airline exited the market, leaving five existing agreements to receive anti-trust immunity in addition to two new agreements that were requested during the assessment process. This series of decisions has provided us with a unique opportunity to evaluate the impact of the different virtual codeshare agreement types on frequency and transacted prices in international markets.[4] Specific details of the type of codeshare agreement between private entities are generally confidential and not available to researchers. To the best of our knowledge this is the first manuscript to analyze the effects of the type of codeshare on aviation markets.

In international airline markets there is an additional layer of regulation that may affect services offered and subsequent pricing levels. Governments sign bilateral or multilateral agreements between countries that may restrict the carriers permitted to serve the markets as well as capping frequency and demanding airfare approval or disapproval, depending on the type of agreement signed between the countries involved. There are three distinct aspects written into the bilateral agreements (Doganis, 2002): the first is the bilateral itself that outlines general aspects of the agreement, including regulation of tariffs and capacity; the second outlines the schedule of routes, which describe capacity rights and the level of freedom allocated to each of the operating airlines; and the third is an exchange of notes, often confidential, that modify certain aspects of the agreement.

The literature has generally demonstrated the negative impact of bilateral agreements between countries on airfares. Dresner and Tretheway (1992) show that liberalized bilaterals reduce economy airfares by 35% (but no significant impact was found with respect to business airfares) and recently Winston and Yan (2012) conclude that open skies agreements generate welfare gains across all fare classes. Our research further considers the degree of liberalization and its effect on frequency and transacted fares. In contrast to the existing literature, we define three levels of liberalization: highly regulated Bermuda I markets in which regulators designate one carrier per country and limit frequency, regulated Bermuda II markets in which total frequency or seat capacity is limited, and liberalized markets in which controls are removed permitting free entry of carriers belonging to the relevant countries.

Based on reduced form, supply side regressions, we find that increasing levels of liberalization have a significant positive impact on market level frequency, which reduce the impact of codeshares to insignificance. Based on fixed and mixed effects regressions, we find that pooling and royalty agreements increase fares significantly. Hard block, soft block and free sale codeshares are generally associated with lower airfares, thereby providing overwhelming support to the decision made by the IAA to eliminate pooling and royalty agreements and generally allow other agreement types. However, after focusing on markets without code share agreements and those markets that experienced the removal of codeshare agreements (without replacement), it would appear that free sale agreements bear the highest benefit to consumers followed by hard block agreements. As shown in Adler and Hanany (2015), under asymmetric and uncertain demand, codesharing on parallel links may be preferable to competitive outcomes for multiple consumer types. Hence, in hub to hub markets, it may not be necessary for governments to carve-out such links or introduce alternative restriction such as frequency freezes or price monitoring, rather it may be sufficient to impose restrictions on the type of codeshare signed. Consequently, it is not only the existence of a contract but the type of contract that impacts airfare levels, which may shed light on the conflicting results published in the literature to date.

We discuss the codesharing mechanism and elaborate on the different types in Section 2. In Section 3 we present the data to be analyzed. Sections 4 and 5 specify the estimations and discuss the results of the analysis with respect to frequencies and transacted airfares, respectively. Section 6 draws conclusions and suggestions for future research.

2. Codesharing: theory and practice

The codeshare contract may be one of five different types as discussed in the literature (Doganis, 2002), ranging from the relatively loose free-sale agreement, to the tighter hard or soft block-space style agreements, to the anti-trust immune pooling and royalty agreements. Under a free sale agreement, seats are not allocated to the marketing carrier, rather their computer reservation system directly accesses the operating carrier's system for information on booking class availability and the level of capacity available on the codeshared flight. Hence, both carriers sell seats from the same general inventory although capacity constraints on the marketing carrier's inventory might be set by the operating carrier. Since the operating carrier bears the entire financial risk in this contract, it also receives the majority of the revenues from ticket sales. The marketing carrier receives a fixed commission as a percentage of the airfare which covers marketing and other associated costs, such as frequent flyer points. Clearly the incentive to increase airfares under this contract exist, although Ito and Lee (2005) argue that the marketing carrier generally does not profit from this transaction, therefore free sale agreements are carefully balanced so that each of the carriers assume the marketing or operating role on an equivalent number of routes to ensure both sides benefit from the agreement.

Under a hard block agreement, the marketing carrier purchases a fixed number of seats from the operating carrier, which it subsequently markets independently. The blocked seats may include first, business and economy class seats. The risk for the codeshare block space is thus borne by the marketing carrier. The marketing carrier is solely responsible for ticket sales and therefore also retains all revenues or losses for the block space. Frequently, the transfer price of such blocks is zero because the arrangement is carefully balanced and includes a symmetric seat swap. Although this mechanism is less complicated to manage than a free sale agreement, for example it does not require a real-time computer connection, it has the disadvantage that it might not be efficient. For example, while one carrier might have surplus capacity, the other may have to refuse customers because all seats have been sold out (Talluri and van Ryzin, 2004). In order to reduce such potential difficulties, the contract often includes a pre-agreed cost per seat such that the marketing carrier is able to request additional seating should they be required. A soft block codeshare also allows the marketing carrier to return up to a portion of the seats on a pre-assigned date prior to the flight,

[3] Prior to the change of the law, local airlines were free to sign codesharing agreements with foreign carriers without oversight or restrictions from the Israeli regulators.

[4] We note that one of the authors was privy to the codeshare agreements as part of an advisory role to the Israeli Antitrust Authority but that a non-disclosure agreement restricts the information in this paper to whatever is available in the public domain. See also http://www.antitrust.gov.il/subject/155/item/26927.aspx for the comprehensive decisions by the Antitrust authority and the descriptions of the (virtual) code share agreements that were reviewed.

which, in turn, passes some of the risk back to the operating carrier.[5]

Pooling agreements set a unit fare, often based on the previous year's revenues collected, and any imbalance between revenues is then transferred to the partner with lower earnings although generally the swap is limited to a maximum percentage transfer. Royalty agreements occur when one airline pays the other airline a percentage of revenue earned on all passengers carried. The US and EU do not permit pooling or royalty agreements without antitrust immunity, leaving opportunities for block contracts and free sale agreements alone.

The incentives for airlines to engage in codesharing are numerous.[6] The most obvious motive is to enhance the route network given a complementary codeshare and to increase service frequency on routes already served under parallel codesharing. This may be achieved without bearing the risk or the cost of operations. In the case of traditional codesharing, airlines link their networks to provide coordinated, seamless service from origin to destination, hence both benefit financially as each carrier receives the revenues from their segment of the operation. Codeshare partners thus aggregate demand and load factors. Under a competitive situation, the passenger may have selected alternate carriers were it not for the marketing carrier's ability to offer the itinerary for a single price.

Additional incentives for codesharing include elimination of double marginalization thereby reducing airfares and concurrently increasing demand (e.g., Park and Zhang, 2000; Brueckner and Whalen, 2000; Brueckner, 2001, 2003; Bamberger et al., 2004; Armantier and Richard, 2006, 2008; Ito and Lee, 2007; Whalen, 2007). Cooperative pricing by carriers leads to reduced fares for interline passengers compared with non-aligned interline passengers. These observations have been further anchored with a 10-year panel dataset (Brueckner et al., 2013). Gayle (2007) estimates the collusive effects of codeshare agreements and alliances based on a structural approach within a discrete choice framework and did not find any significant departure between collusive and pre-alliance fares for a sample of US domestic routes. According to Oum et al. (1996), complementary codesharing between non-leaders induces the leader to behave more competitively, and expands the residual demand curve. Thus, such an agreement shifts the resulting equilibrium whereby the leader airline increases its output while lowering the airfare.

Although the literature has focused primarily on the effects of codeshare agreements and alliances on airfares, such contracts also lead to the pooling of frequencies, coordination of connections and expansion of networks. Severe concerns have been raised with respect to the softening of competition resulting from such agreements. If the pre-alliance market was served by two carriers, then post-alliance, the carriers are a de facto monopoly. Over time, alliances may lead to reductions in service and ultimately to higher fares. Considering international alliances, Brueckner and Whalen (2000) found that in gateway-to-gateway markets, airfares were approximately 5% higher, although this result was not statistically significant. Studying domestic alliances, Armantier and Richard (2006, 2008) found that prices on non-stop, codeshared flights increased by an average of 10%. Similarly, Gilo and Simonelli (2015) find an increase in non-stop domestic fares due to the "round table" effect (referring to the collusive outcome) as well as due to double marginalization. This is in contrast to Gayle (2008) who did not find evidence that alliances induced collusion on overlapping routes. In addition, Chen and Gayle (2007) argue that double marginalization may not be eliminated in all instances. They study the market structure effects on the impact of codesharing and show that when two airlines offer complementary flights in direct competition to a third airline that offers a direct flight, codesharing eliminates double marginalization however, if the codesharing partner also serves the direct route, double marginalization is not eliminated. In studying nonstop hub-to-hub routes, Wan et al. (2009) conclude that the net effect of alliances on airfares is uncertain due to the trade-off between the positive effect from price collusion and the negative effect from economies of density. Additionally, they find that the different alliances are associated with varying impacts on airfares.

Clearly, codesharing may have both positive and negative effects on competition, depending on the market situation. In parallel markets codesharing is likely to decrease competition as both carriers will be able to reduce the number of flights operated. On the other hand, two carriers servicing complementary routes, then interline codesharing may allow them to compete more efficiently against other carriers servicing the origin-destination market (Hanlon, 2007). Li and Netessine (2011) study the competitive effects of US domestic alliances by analyzing the dynamic change in flight networks due to alliances. They reveal that airlines are more likely to enter or stay in markets where their alliance partners demonstrate strong market power. Adler and Smilowitz (2007) show that there is a strong pressure on airlines to merge, or ally via codeshares if mergers are not permitted, and that such a decision impacts the choice of hubs in the subsequent market.

The implications of codesharing on passengers are also ambiguous. Customers should experience a higher quality of service, specifically on interline codeshare flights, through single check-ins, transfer of baggage, more convenient "seamless" connections and often transferable frequent flyer bonuses. In the case in which competitive effects are positive, passengers should also benefit from lower average fares. However, passengers may not be aware of the codeshare, hence feel deceived later and they may also be confused as to who is responsible should problems arise. For example, the marketing carrier is responsible for reservation issues while baggage loss or damage is handled by the operating carrier (Hanlon, 2007).

The resulting effects of codesharing have been of interest to Departments of Transport and Justice around the world. The United States permits codesharing on all complementary networks but antitrust immunity is only granted after careful scrutiny and has never been permitted on domestic codeshare flights. Conditions in the form of carve-outs on specific routes, such as hub-to-hub connections between partners, have been imposed to remedy any competitive concerns.[7] European carriers are free to enter into specific types of codeshare agreements anywhere within the European Union unless they were to result in a monopoly route.

[5] Steer Davies Gleave (2007) describes additional technical elements and clauses in the process of streamlining the codesharing agreements between airlines. A related challenging question faced by airlines is the compensation for the leg operated by the other carrier. Xu et al. (2013), as well as Wright et al. (2010) and Gerlach (2013), propose a set of agreements such as transfer price or revenue proration schemes to facilitate the efficient allocation of profits between members of the agreement that exceed benchmark proration rules which may be mileage- or fare-based. Such rules would be more suitable for complementary networks and abstract away from issues observed in practice with respect to codeshare agreements—such as the number of seats allocated for sharing and the timing of seat returns—all of which have implications with respect to risk and access to inventory, hence pricing.

[6] As airlines engage in codesharing agreements they may choose a tactical or a strategic partnership, involving either a limited set of routes or a substantial portions of the partners' routes, respectively (Iatrou and Oretti, 2007).

[7] If an alliance does not involve full integration of the partners' operations on the hub to hub route, Brueckner and Proost (2010) show that such carve-outs may be beneficial. However, with greater integration, the carve-out prevents the alliance from taking advantage of economies of traffic density on the hub-to-hub market thus welfare may be reduced. Brueckner (2003) finds that the airfare reduction is amplified when antitrust immunity is granted to the carriers, as such collaborations allow carriers to internalize the double marginalization and offer lower airfares.

Please cite this article as: Adler, N., Mantin, B., Government and company contracts: The effect on service and prices in international airline markets. Economics of Transportation (2015), http://dx.doi.org/10.1016/j.ecotra.2015.05.005

The EU-US open-skies policy that came into effect in March 2008 permits codesharing and wet leasing between US and EU carriers provided approval would not give rise to competitive concerns. However, whilst the EU is more lenient than their US counterpart, they are more likely to impose stringent conditions on such agreements, including slot divestiture, frequency freezes, interline obligations, price constraints and access to frequent flyer programs, in order to encourage competition in the aviation markets.

We now move on to measuring the impact of the type of codesharing contracts and bilateral agreements on market level frequency, as a proxy for service levels, and airfares as a proxy for the utility of a trip. The results of the analysis ought to be of interest to those developing aviation markets and those who regulate them via bilaterals or multilaterals.

3. Data collection to analyze international, regulated aviation markets

Our analysis comprises two sets of estimations. In the first set we estimate the implications of government agreements and codeshare contracts on frequencies, whereas, in the second set, we focus attention on the implications with respect to transacted airfares. The frequencies and transacted airfares analyses are carried out separately, however complementary data is applied to both sets of estimations. We first describe the two data sets and then the collection of complementary data.

Flight frequencies: This data was aggregated on a country basis for several reasons. Inter government air service agreements identify all markets between the two countries that may be served, either specific airports or city pairs in a restricted agreement or all potential airports in a liberalized, open skies contract. Second, if a carrier shifts supply from one market to another within the same country, overall supply is likely to remain fixed, ceteris paribus. Frequency is measured by aircraft movements on a monthly basis. Data on aircraft movements to all countries served by El Al, the privatized Israeli national carrier, was collected from the Israeli Civil Aviation Authority on a monthly basis.

Transacted airfares: Marketing Information Data Tapes (MIDT) was purchased to provide itinerary information on travel to and from Israel for March 2008 and March 2010 in order to capture the impact of the change in the rules regarding codesharing contracts which occurred in 2009. Characteristics include great circle distance, number of stops, marketing carrier, operating carrier, booking time, travel time and ticket class. After cleaning the dataset, we focus attention on travel to and from destinations (cities) directly served by El Al, the privatized Israeli national carrier, for which 400,000 observations remained (150,000 in 2008 and 250,000 in 2010). Additional data on frequencies and enplanements was gathered from the Israeli Civil Aviation Authority. There are a total of 54 city pairs[8] in the dataset and 168 origin-destination-airline triplets.

Complementary data collected in order to explain frequency and pricing decisions are as follows.

Market characteristics: We collected data on the great circle distance (*Distance*) between Tel Aviv and 54 cities, as well as the population size (*POP*) and gross domestic product per capita (*GDPC*) of corresponding countries, drawn from the World Bank database. Additionally, based on flight frequency data obtained from the Israeli Aviation Authority, we derive a competition intensity measure, HHI, which takes values between 0 and 1, where the former reflects the theoretical level of pure competition and the latter indicates a monopoly market in the non-stop link.

Product quality: We identified all airlines that are classified as low cost carriers or charters (d*LCC*/*CH*). Such carriers are expected to offer lower fares as their cost structure is different to that of the scheduled, full-service carriers. We also test for the impact of airline alliances by developing a dummy for One World, Skyteam and Star (*Alliance*), which receive a value of one provided the relevant operating carrier belongs to one of these groups in the specific timeframe.[9] The airlines differ in many dimensions of service, such as the boarding process, service standards on board and seat dimensions. We attempt to differentiate among the carriers with respect to service by testing the Skytrax ranking (*AirlineScore*). Skytrax audits airlines and ranks them based on 800 areas of product and service delivery. The final rating categorizes airlines into one of five categories with 5-star ranking being the highest.[10] Another measure of itinerary quality is captured through the number of legs the itinerary contains (*Legs*).[11]

Dynamic pricing and revenue management: Airlines apply a variety of mechanisms to differentiate between passengers. The two primary segmentation mechanisms relate to the timing of the purchase and the class purchased. Facilitating inter temporal discrimination between the different types of passengers that purchase tickets, airfares generally rise as the time to departure nears (Bilotkach et al., 2010; Escobari and Gan, 2007; Mantin and Koo, 2009). The variable *AdvanceTime* measures the number of days between the date of ticket purchase and the departure date.[12] Airlines segment their customers by offering different seat classes. Sometimes classes have dedicated cabins and clearly differentiated products, but sometimes the classes simply offer different levels of flexibility (coupled with the above-mentioned inter-temporal discrimination, some of the lower classes may not be available for purchase as time to departure approaches). We aggregate the different ticket types into four broad categories: *ClassD* which represents the standard coach class, *ClassD*1 which represents premium coach tickets, *ClassB* and *ClassF* which represent Business and First class respectively. Market segmentation can also occur based on travel days because business travelers traditionally prefer to travel on specific days in order to be at home over the weekend. To account for this element in the airlines' revenue management systems, we add dummies for each day of the week (*DayX*). El Al is the hub carrier in this study and as the national carrier of Israel, the airline follows the Jewish laws of Sabbath which means that it does not fly on Saturday, the service providers speak Hebrew and security measure are quite strict. Therefore, we add an El Al dummy to account for itineraries marketed or operated by El Al (*dLY*).

Liberalization measures: all international routes are regulated according to bilateral, multilateral or horizontal agreements, generally signed by Civil Aviation Authorities. Such agreements may designate specific airports and carriers, the number of carriers approved to operate scheduled flights, the number of approved

[8] Five cities possess multiple airports in the dataset including Berlin, London, Moscow, New York, and Paris.

[9] While we control for an airline's participation in an alliance, the fact that some of these alliances may compete with each other is beyond the scope of our current research, primarily because El Al does not belong to an alliance. For alliance competition effects, the reader is referred to Bilotkach (2005), Brueckner and Pels (2005), Zhang and Zhang (2006), and Flores-Fillol and Moner-Colonques (2007).

[10] In a limited number of cases, primarily for LCCs, the rating was missing and an estimate was generated based on passenger feedback and the authors' experience.

[11] The number of legs in a directional trip in our sample is either 1 or 2. In the original data a very small fraction of passengers flew a 3-leg trip and these observations were removed.

[12] *AdvanceTime* attempts to capture the likelihood that the passenger is flying for purposes of leisure or business, since the latter is more likely to purchase a ticket closer to the departure date, irrespective of the seat class.

Please cite this article as: Adler, N., Mantin, B., Government and company contracts: The effect on service and prices in international airline markets. Economics of Transportation (2015), http://dx.doi.org/10.1016/j.ecotra.2015.05.005

Table 1
Levels of liberalization between Israel and 38 countries.

Country	Liberalization level					Country	Liberalization level				
	2007	2008	2009	2010	2011		2007	2008	2009	2010	2011
Austria	0	0	0	0	0	**Jordan**	0	0	0	0	1
Azerbaijan	0	0	0	0	0	**Korea, Rep.**	0	1	1	1	1
Belarus	0	0	0	0	0	**Latvia**	0	0	0	0	0
Belgium	0	1	1	1	1	**Moldova**	0	0	0	0	0
Bulgaria	0	0	0	0	0	**Netherlands**	0	0	0	0	0
Canada	0	0	0	0	0	**Poland**	0	0	0	0	0
China	0	0	0	0	0	**Romania**	0	0	0	0	1
Cyprus	0	0	0	0	0	**Russian Federation**	0	0	0	0	0
Czech Republic	0	0	0	0	0	**Serbia**	0	0	0	0	0
Egypt, Arab Rep.	0	0	0	0	0	**Slovak Republic**	0	1	1	1	1
Ethiopia	0	0	0	0	0	**South Africa**	0	0	0	0	0
France	1	1	1	1	1	**Spain**	1	1	1	1	1
Georgia	0	0	0	0	0	**Switzerland**	0	0	1	1	1
Germany	1	1	1	1	1	**Thailand**	1	1	1	1	1
Greece	0	0	0	1	1	**Turkey**	2	2	2	2	2
Hong Kong	0	0	0	0	0	**Ukraine**	0	0	0	1	1
Hungary	0	0	0	0	1	**United Kingdom**	0	1	1	1	1
India	0	0	0	0	0	**United States**	2	2	2	2	2
Italy	0	1	1	1	1	**Uzbekistan**	0	0	0	0	0

frequencies or seat capacity permitted and they may also have fare approval or disapproval clauses. We identify three primary levels: at level 0 agreements permit only a single designated carrier per country, at level 1 the two countries designate more than a single carrier per country, and at level 2, the most relaxed type of agreement, no carriers are designated and the frequency of flight restrictions are either higher than the current service provision or unlimited.[13] Since the effects may be non-linear, we develop two dummy indices: *1.Liber* that takes a value of one if the agreement between the two countries belongs to level 1, and *2.Liber* which equals one if the agreement belongs to level 2. The levels of liberalization between Israel and each of the countries in our databases are summarized in Table 1.

Codeshare agreements: we dedicate a codeshare dummy (*CS*) that receives a value of one if a codeshare, of any type, is present in the market. To estimate the unique effects of the specific codeshare types, we introduce codeshare dummies for the various agreements. Specifically, five types of codeshare agreements are present in our data: pooling agreements (*POOL*), free sale agreements (*FS*), soft block (*SB*), hard block (*HB*), and royalties (*ROYAL*). In one case, insufficient data was available, and the agreement was recognized as a codeshare (*CS*) without any specification. After the review by the Israeli Antitrust Authority (IAA), pooling and royalty agreements were discontinued in 2009.

Table 2 summarizes the changes in codeshare agreements between 2008 and 2010 following the review carried out by the IAA. The identity of the various markets cannot be revealed due to a non-disclosure agreement except for the reviews that were made public. This table shows that 13 variations in codeshare agreements occurred. We note that the number of markets exceeds the number of countries when several destinations are served per country.[14]

Table 2
Overview of Codeshare agreements before and after the review by the IAA.

Contract in 2008	Contract in 2010	Number of markets
Free sale	Free sale	5
Free sale	None	3
Hard block	Hard block	2
Hard block	None	5
Pooling	Hard block	1
Pooling	None	2
Royalties	None	1
Soft block	Soft block	1
Soft block	None	3
Unknown CS	None	3
None	Free sale	1
None	Soft block	1
None	None	32

As revealed in the analysis presented in Section 5, different codesharing agreements imply various levels of impact on airfares. In an attempt to explore whether the characteristics of a country influence the type of codeshare approved by the regulators, we collected data on the corruption perception index (CPI) from Transparency International. We could not find any evidence that a specific type of agreement, such as royalties or pooling, was more likely to emerge in countries with lower CPI measures.

Data overview: Table A.1 in Appendix A presents the summary statistics of the dataset. The average GDP per capita increased from 2007 to 2008 and then dropped by 9%, returning to 2007 levels by 2010 in the dataset. We thus note that the span of the data includes the financial crisis of 2008 which impacted airline markets substantially. The average population of the destinations consistently increased and lies on average at 104 million inhabitants. The majority of itineraries were direct and tickets were purchased six weeks in advance on average. El Al marketed almost 50% of the itineraries and produced about a third of the flights indicating the use of relatively large aircraft with reasonable load factors. Low cost carriers and charters comprise 15% of the 54

[13] Both Turkey and the US signed revised agreements with Israel in December 2009 and December 2010, respectively. However, the revised agreements replace earlier agreements which were very liberal and allowed much freedom in terms of entry.

[14] We note that in our analysis we have accounted only for codeshare agreements between El Al and a foreign carrier since this is the information to which we were privy. Furthermore, the virtual codeshare agreements covered all non-stop markets within the same country of the foreign carrier using the same agreement type. Were a third carrier to operate in the market, the relevant codeshare dummy should be zero however this did not arise in our dataset. On the other hand, we do include an Alliance dummy which should capture the effect caused by additional contracts between foreign carriers.

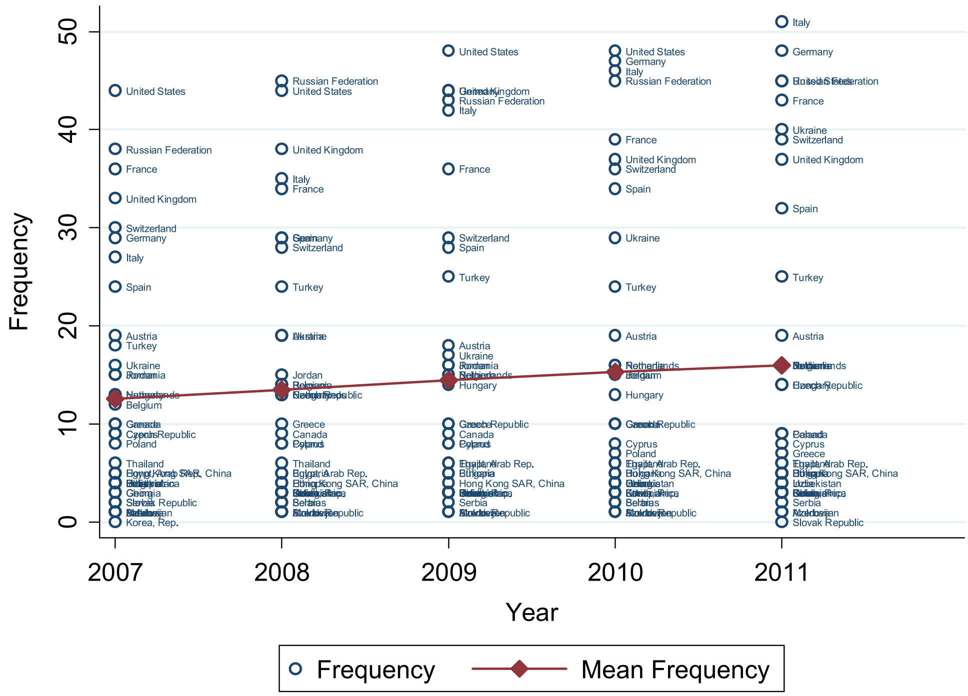

Fig. 1. Total frequencies from Tel Aviv to destination country from 2007 to 2011.

carriers in our database, however they account for less than 3% of total enplanements. We find that 46% of the carriers in our database belong to one of the three airline alliances (Star Alliance, Oneworld, or Sky Team).

4. Liberalization, codesharing and service levels

In this section, we describe the impact of liberalization and codesharing on frequency. Specifically, we analyze the planned flight schedules of all airlines serving the Tel Aviv market over a span of five years from 2007 to 2011. We are searching for the impact on flight frequency, if any, of the types of codeshare agreements between airlines and the level of bilateral liberalization between countries. We conduct the regressions at a country level, rather than at the airline-destination level, because we are interested in the market equilibrium frequency outcome rather than the airline specific decisions.[15] We consider aggregate scheduled flights to each country for the winter seasons from 2007 to 2011. 38 countries were served in each of these years (except for 2007 and 2011, for which we have only 37 observations) hence the dataset consists of a total of 188 observations. Fig. 1 depicts the changes in market frequency per country from which it is evident that frequency has steadily increased over the years on average.

Disaggregating the frequency by country in Fig. 2, a more complex picture emerges, in which half the countries experience little change in frequency, a quarter increase steadily over time, and several others are served by fluctuating frequencies, such as the United Kingdom, Russian Federation and the US.

In order to investigate the impact of codeshare contacts and bilateral agreements, we estimate reduced-form supply-side equations using two sets of regressions. In the first set, codeshare agreements are broadly defined by a single dummy variable (Eq. 1).

$$\log\left(Frequency_t^i\right) = \gamma_t + \alpha^i + \alpha_1 Distance_t^i + \alpha_2 GDPC_t^i + \alpha_3 Population_t^i + \alpha_4 1.Liber_t^i + \alpha_5 2.Liber + \alpha_6 CS_t^i + \varepsilon_t^i, \quad (1)$$

where $Frequency_t^i$ is the total frequency to market i in period t, γ_t is the annual fixed effect and α^i is the route fixed effect. The variable CS implies that there is a contract on the hub to hub market between El Al and another carrier from the corresponding country. In the second set of regressions (Eq. (2)), codeshare dummies are allocated to each of the codeshare agreement types: Free Sale (FS), Hard Block (HB), Pooling (POOL), Royalties (ROYAL) and Soft Block (SB).

$$\log\left(Frequency_t^i\right) = \gamma_t + \alpha^i + \alpha_1 Distance_t^i + \alpha_2 GDPC_t^i + \alpha_3 Population_t^i + \alpha_4 1.Liber_t^i + \alpha_5 2.Liber_t^i + \alpha_6 FS_t^i + \alpha_7 HB_t^i + \alpha_8 POOL_t^i + \alpha_9 ROYAL_t^i + \alpha_{10} SB_t^i + \varepsilon_t^i. \quad (2)$$

The estimation results of (1) and (2) are provided in Table 2, including pooled data across the five years, fixed effects[16] and mixed effects models. The mixed effects models enable estimation of the coefficients of Distance and *2.Liber*, which is not true for the fixed effects model because the two variables are invariant over time, as indicated for the case of *2.Liber* in Table 1.

In general, as expected, distance is negatively associated with frequency hence the longer the distance, the lower the frequency. As distance increases, airfares increase and demand is consequently lower. Furthermore, for destinations greater than 5000 km airlines tend to operate wide-body aircraft with higher

[15] At the airline level, a decision to change frequency to one destination could affect frequency decisions to alternative destinations, since the fleet size is fixed in the short run and cannot be altered to address changes in total frequency. In addition, codeshare contracts and liberalization agreements could also affect frequency. For example, the liberalization of the skies may induce new players to enter the market, thereby stimulating a reduction in frequency by existing carriers. Hence, our attention is focused at the market level frequency equilibrium.

[16] Following the Hausman test, we use fixed effects over random effects.

Please cite this article as: Adler, N., Mantin, B., Government and company contracts: The effect on service and prices in international airline markets. Economics of Transportation (2015), http://dx.doi.org/10.1016/j.ecotra.2015.05.005

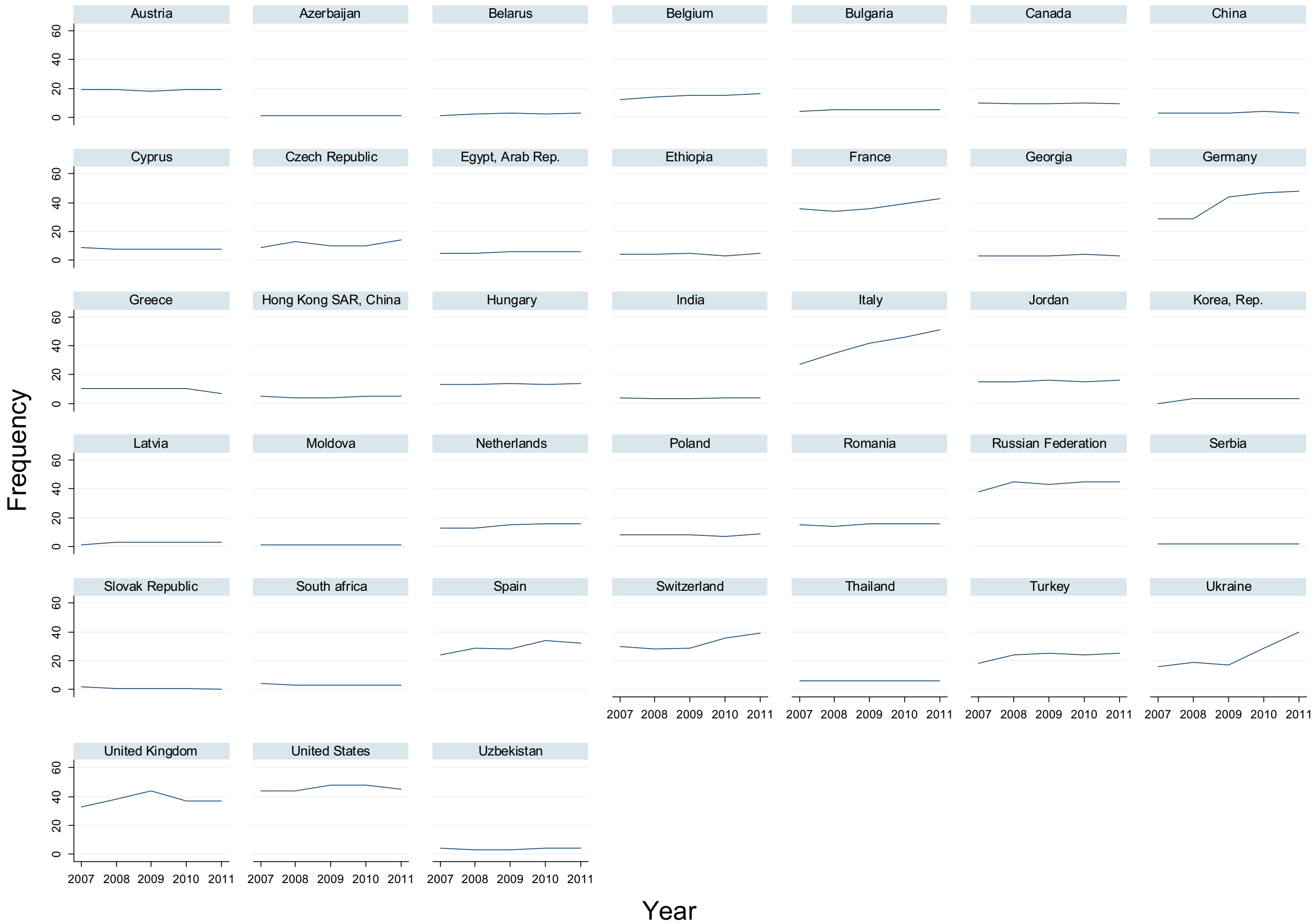

Fig. 2. Total frequencies from Tel Aviv per destination country from 2007 to 2011.

seat counts, which further limit frequency. GDP per capita is generally significant and positive suggesting that higher levels of economic activity are associated with more business-driven demand for travel and since GDP per capita is related to income levels of the population, the greater wealth permits more airborne travel. The lack of significance in the fixed effects regressions suggests that changes in GDP per capita over time have not been sufficiently substantial as to stimulate change in the overall supply of flights. The size of the population contributes to greater frequency but similar to GDP per capita, changes over time have had insignificant impact on frequency. We note that we also considered the potential effect of trade levels between countries on frequency of flights in a separate set of regressions, but this proved insignificant hence is not reported in Table 3.

In the first set of regressions, in which codeshares are captured via a single dummy variable, we would expect that in the presence of CS, airlines should be in a position to better coordinate their flight schedules and possibly reduce the number of flights operated in the market. However, the CS dummy is not significant (except in the pooled regression).[17] In the second set of regressions, the different codeshare types are associated with separate dummy variables (Table 2). In these regressions one would expect that block agreements may have limited effect on frequency, whereas royalty agreements would result in a much reduced frequency because one of the airlines exits or refrains from entering the market resulting in a monopolistic setting. Somewhat surprisingly, none of the codeshare specific dummies is significant, except in the pooled regression (as discussed in Footnote 17).

On the other hand, the regressions reveal that the impact of liberalization on city-pair frequencies is rather significant and positive. When two countries sign a more liberalized agreement, the frequency of flights is significantly higher, more so with *2.Liber* than with *1.Liber*. Evidently, the magnitude of *2.Liber* is much higher than the magnitude of *1.Liber*, implying that countries signing open skies agreements with Israel led to a substantial increase in the frequency of flights as compared to the Bermuda I style agreement.[18]

These results suggest that yields in the regulated markets were sufficiently high and the restrictions on frequency sufficiently tight that new entry was induced as a result of the more liberalized bilaterals. It may be true that this is a short-run effect and that in the longer term, with sufficient new entry, the yields will eventually drop and frequency retractions may occur, however this will need to be the subject of future research, once sufficient time has passed. An alternative explanation for these results may argue that liberalized routes occurred in markets with relatively high demand a-priori.

[17] In the pooled regression, the coefficient of the CS variable is positive and significant at the 5% level, implying that in markets where a codeshare contract was present, the frequency was about 31% higher. However, this does not hold in any of the other estimations in which the CS dummy is negative and insignificant, suggesting that fixed effects regressions are important to understand the markets accurately.

[18] We note that Israeli airlines have been prevented from serving the Turkish market since 2009 due to security concerns.

Table 3
Impact of codeshare contracts and liberalization agreements on market frequency.

ln Frequency	Equation (1)			Equation (2)		
	Pooled	Fixed effects	Mixed effects	Pooled	Fixed effects	Mixed effects
Codeshare (CS)	0.311*	−0.0136	−0.0121			
	(0.128)	(0.0497)	(0.0488)			
Free Sale (FS)				0.0606	0.0424	0.0432
				(0.168)	(0.0962)	(0.0909)
Hard Block (HB)				0.373+	−0.148	−0.128
				(0.223)	(0.111)	(0.108)
Soft Block (SB)				−0.111	0.0378	0.0261
				(0.245)	(0.0930)	(0.0908)
Pooling (POOL)				0.472**	0.0406	0.0452
				(0.155)	(0.118)	(0.114)
Royalties (ROYAL)				−0.443**	−0.240	−0.198
				(0.169)	(0.269)	(0.158)
Weak Liberalization (*1.Liber*)	0.554**	0.161*	0.159*	0.639**	0.150	0.153+
	(0.152)	(0.0779)	(0.0761)	(0.177)	(0.0907)	(0.0867)
Open Skies (*2.Liber*)	1.512**		1.376*	1.566**		1.375*
	(0.0929)		(0.666)	(0.102)		(0.673)
Distance (10^{-3})	−0.118**			−0.111**		
	(0.0155)			(0.0184)		
GDPC (10^{-3})	0.0358**	0.00173	0.0150**	0.0332**	0.00204	0.0145**
	(0.00299)	(0.00689)	(0.00537)	(0.00339)	(0.00702)	(0.00543)
POP (10^{-9})	0.000331**	0.00248	−0.000181	0.000482**	−0.00117	−0.000249
	(0.000112)	(0.00305)	(0.000525)	(0.000135)	(0.00510)	(0.000531)
constant	1.441**	1.788**	1.718**	1.476**	2.175**	1.739**
	(0.125)	(0.346)	(0.195)	(0.131)	(0.550)	(0.195)
N	188	188	146	188	188	146
Adj. R^2/LL	0.501	0.976	−33.53	0.489	0.976	−31.34

Notes: Standard errors in parentheses are robust in the OLS estimations; all regressions include annual fixed effects dummies.

+ $p < 0.10$.
* $p < 0.05$.
** $p < 0.01$.

However, since the choice of bilateral is a political decision reached at the level of the Ministries of Transport, Justice and higher, it is equally possible that the choice of bilateral has little connection to the current market demand between two countries. To conclude, the results of the estimation models suggest that liberalization agreements are strongly associated with market level frequency whereas codeshare agreements have little to no impact on frequency levels.

5. Liberalization, codesharing and airfares

In this section we explore the extent to which codeshare contract types and levels of liberalization affect airline pricing decisions as defined in Eq. (3).

$$\begin{aligned}\log\left(Fare_t^{ijk}\right) = {} & \gamma_t + \alpha^i + \alpha_1 Distance_t^i + \alpha_2 GDPC_t^i \\ & + \alpha_3 Legs_t^i + \alpha_4 AdvanceTime_t^i + \alpha_5 dLCC/CH_t^{ik} \\ & + \alpha_6 AirlineScore_t^k + \alpha_7 AllianceDummy_t^k \\ & + \alpha_8 OperatingFrequency_t^{ik} + \alpha_9 HHI_t^i \\ & + \alpha_{10} ClassD1_t + \alpha_{11} ClassB_t + \alpha_{12} ClassF_t \\ & + \alpha_{13} 1.Liber_t^i + \alpha_{14} 2.Liber_t^i + \alpha_{15} FS_t^i + \alpha_{16} HB_t^i \\ & + \alpha_{17} POOL_t^i + \alpha_{18} ROYAL_t^i + \alpha_{19} SB_t^i + \alpha_{20} dLY_t^i \\ & + \sum_{x=1}^{6} \alpha_{x+20} DAY_t^x + \varepsilon_t^{ijk},\end{aligned} \tag{3}$$

where $Fare_t^{ijk}$ is the fare paid by customer j for a ticket in market i for an itinerary operated by airline k during period t, where $t \in$ {March 2008, March 2010}, γ_t is the annual fixed effect and α^i is the route fixed effect. To compare our results with earlier research on the effect of codesharing agreements, we also estimate (3) where we replace the code share types (FS, HB, POOL, ROYAL, and SB) with the variable CS that merely captures the presence of a codesharing agreement in the corresponding market. We test both fixed and mixed effects models (Table 4), where the latter allows us to estimate the coefficients that do not change over time.

In Table 4, the standard variables indicate, as expected, that the more circuitous the route (*Legs*), the earlier the ticket is purchased (*AdvanceTime*) and the shorter the great circle distance (*Distance*), the lower the airfare. Similarly, flights to countries with higher GDP per capita (GDPC) and higher classes (*ClassD1/B/F)* are associated with more expensive airfares. The low cost carriers and charter airlines (*dLCC/CH*) charged about 25% lower airfares, whereas the higher quality airlines (*AirlineScore*), according to the Skytrax rating, charged approximately 13% higher airfares for each additional star ranking they possess. Airlines belonging to alliances (*Alliance*) were also in a position to charge a premium of approximately 6%. The importance of competition is revealed by the coefficient of the *HHI* which shows that as competition intensity is relaxed, the fares increase substantially. Additionally, we find that airlines charge higher fares as their frequency on the route (*OpFreq*) increases. El Al (*dLY*), as the local hub carrier, achieves a hub premium of approximately 20%. Finally, prices on weekdays (*Day1–6*) are lower than on Saturdays, when the hub carrier chooses not to serve the market in keeping with religious Jewish laws. The reduction in supply and competition on this day leads to higher yields for the foreign carriers.

The regressions reveal that liberalization is significant with a negative effect on airfares. Weak liberalization (*1.Liber*) decreases airfares by about 4%, whereas strong liberalization (*2.Liber*), for which we apply the mixed effect regression,[19] is only weakly

[19] Recall that in our data *2.Liber* is present in only two countries and that in both cases the strong liberalization existed in both years.

Please cite this article as: Adler, N., Mantin, B., Government and company contracts: The effect on service and prices in international airline markets. Economics of Transportation (2015), http://dx.doi.org/10.1016/j.ecotra.2015.05.005

Table 4
Impact of codesharing contracts and liberalization on airfares: fixed and mixed effect estimations.

LnFare	Fixed effects: no CS	Fixed effects: CS dummy	Fixed effects: CS types	Mixed effects: CS dummy	Mixed effects: CS types
Legs	−0.139**	−0.139**	−0.139**	−0.139**	−0.139**
	(0.00204)	(0.00204)	(0.00204)	(0.00204)	(0.00204)
Distance (10^{-6})				80.29*	80.51*
				(33.35)	(33.66)
AdvanceTime (10^{-3})	−1.440**	−1.439**	−1.438**	−1.439**	−1.438**
	(0.0119)	(0.0119)	(0.0119)	(0.0119)	(0.0119)
GDPC (10^{-6})	30.36**	30.86**	31.16**	30.40**	30.68**
	(0.507)	(0.513)	(0.525)	(0.509)	(0.521)
dLCC/CH	−0.224**	−0.225**	−0.222**	−0.226**	−0.222**
	(0.00432)	(0.00432)	(0.00434)	(0.00432)	(0.00434)
AirlineScore	0.126**	0.126**	0.126**	0.126**	0.126**
	(0.00200)	(0.00200)	(0.00201)	(0.00200)	(0.00201)
Alliance	0.0661**	0.0650**	0.0645**	0.0649**	0.0644**
	(0.00298)	(0.00299)	(0.00300)	(0.00299)	(0.00300)
OpFreq	0.0000843**	0.0000959**	0.0000959**	0.0000959**	0.0000957**
	(0.0000223)	(0.0000224)	(0.0000224)	(0.0000224)	(0.0000224)
HHI	0.286**	0.308**	0.296**	0.308**	0.297**
	(0.0160)	(0.0164)	(0.0164)	(0.0163)	(0.0164)
ClassD1	0.349**	0.349**	0.348**	0.349**	0.348**
	(0.00250)	(0.00250)	(0.00250)	(0.00250)	(0.00250)
ClassB	0.544**	0.544**	0.544**	0.544**	0.544**
	(0.00228)	(0.00228)	(0.00228)	(0.00228)	(0.00228)
ClassF	0.549**	0.549**	0.550**	0.549**	0.549**
	(0.00329)	(0.00329)	(0.00329)	(0.00329)	(0.00329)
CS		−0.0190**		−0.0187**	
		(0.00291)		(0.00291)	
ROYAL			0.0351**		0.0341**
			(0.0123)		(0.0123)
POOL			0.0134*		0.0136*
			(0.00661)		(0.00661)
SB			−0.0184**		−0.0176**
			(0.00589)		(0.00589)
HB			−0.0254**		−0.0258**
			(0.00707)		(0.00707)
FS			−0.0353**		−0.0345**
			(0.00544)		(0.00544)
Day1	−0.0269**	−0.0269**	−0.0270**	−0.0269**	−0.0271**
	(0.00253)	(0.00252)	(0.00252)	(0.00252)	(0.00252)
Day2	−0.0586**	−0.0585**	−0.0588**	−0.0585**	−0.0588**
	(0.00255)	(0.00255)	(0.00255)	(0.00255)	(0.00255)
Day3	−0.0574**	−0.0572**	−0.0575**	−0.0572**	−0.0575**
	(0.00264)	(0.00264)	(0.00264)	(0.00264)	(0.00264)
Day4	−0.0479**	−0.0479**	−0.0481**	−0.0478**	−0.0481**
	(0.00259)	(0.00259)	(0.00259)	(0.00259)	(0.00259)
Day5	−0.0184**	−0.0182**	−0.0185**	−0.0182**	−0.0185**
	(0.00259)	(0.00259)	(0.00259)	(0.00259)	(0.00259)
Day6	−0.0101**	−0.0101**	−0.0103**	−0.0101**	−0.0103**
	(0.00289)	(0.00289)	(0.00289)	(0.00289)	(0.00289)
dLY	0.181**	0.180**	0.180**	0.180**	0.180**
	(0.00258)	(0.00259)	(0.00260)	(0.00259)	(0.00260)
1.Liber	−0.0334**	−0.0410**	−0.0417**	−0.0404**	−0.0412**
	(0.00476)	(0.00490)	(0.00570)	(0.00490)	(0.00570)
2.Liber				−0.585+	−0.581+
				(0.306)	(0.309)
2010Dummy	0.0412**	0.0401**	0.0426**	0.0392**	0.0416**
	(0.00173)	(0.00174)	(0.00178)	(0.00174)	(0.00178)
Constant	4.425**	4.409**	4.405**	4.368**	4.365**
	(0.0218)	(0.0219)	(0.0221)	(0.124)	(0.126)
# of observations	395423	395423	395423	395423	395423
Adjusted R^2/LL	0.607	0.607	0.607	−165822.13	−165798.18

Notes: Standard errors in parentheses are robust in the OLS estimations; all regressions include annual and market fixed effects dummies.

+ $p < 0.10$.
* $p < 0.05$.
** $p < 0.01$.

significant with a very strong negative effect. The weak significance could be a result of the fact that *2.Liber* was signed only for two of the countries in the dataset. Consequently, we draw the conclusion that partial regulation has a limited effect on frequency that consequently resulted in a small, but significant effect on airfares. Full deregulation, in which free entry is permitted, leads to a significant increase in frequency and ultimately to a potentially substantial lowering of airfares. The large reduction in airfares is consistent with the results of Dresner and Tretheway (1992), who found that U.S. liberalized bilaterals further reduced discounted airfares by 35% with no significant effect on business airfares.

With respect to codesharing, the results of Table 4 indicate that a codesharing agreement in general would be associated with lower transacted airfares of about 2% in the hub-to-hub international markets analyzed in this dataset. This is a change as compared to some of the current literature however it is important to distinguish between interlining and virtual codeshare passengers. For interlining, the literature has predominantly suggested that horizontal agreements have resulted in reduced airfares primarily due to the elimination of double marginalization (for example Park and Zhang, 2000; Brueckner and Whalen, 2000; Brueckner, 2001, 2003; Bamberger et al., 2004; Armantier and Richard, 2006, 2008; Ito and Lee, 2007; Whalen, 2007). For virtual codeshares, some evidence suggests that fares may increase on non-stop flights (Brueckner and Whalen, 2000; Armantier and Richard, 2006, 2008) or show no sign of collusion (Gayle, 2008). Hence, the existing literature suggests that interlining may reduce airfares, whereas codesharing agreements on non-stop flights might enable airlines to achieve higher levels of (implicit) coordination, reducing competition in the market and pushing fares upwards. However, our result implies that the reduction in airfares due to horizontal agreements between airlines extends to non-stop (overlapping) routes in international markets too, depending on the agreement type.

Our interest, therefore, is in understanding the effect of the *types* of codeshare agreements, which reveal a more complex picture. We find that pooling and royalty agreements had a significant and positive impact on airfares, leading to an increase of about 1.3% and 3.5%, respectively.[20] Indeed, no pooling or royalty agreements were approved by the Antitrust Authority in 2009, hence only three codesharing types remained by 2010. Free sale, hard block and soft block agreements, on the other hand, are associated with a decrease in fares of approximately 3.5%, 2.5% and 1.8%, respectively. The estimated coefficients from the mixed effects regressions reveal similar observations.[21]

These results carry several messages for regulators. We find that both royalties and pooling agreements are associated with a significant increase in transacted airfares, as such agreements lead to de-facto monopolistic operations in these markets. Perhaps surprisingly, block contracts enable carriers to offer an enhanced schedule and lead to lower airfares. A soft block contract has the smallest impact on airfares, possibly because of the higher risk faced by the operating carrier who may have seats returned from the marketing carrier a couple of weeks prior to the flight. Hard block codeshares share the risk more equally across all flights in the relevant season. Free-sale contracts, which permit the operating carrier greatest control over their own supply, lead to the largest reductions in airfares.

In the dataset we cover a total of 60 markets in 40 countries. In 32 of these markets, no code share agreements were signed before or after the review conducted by the IAA and in 14 of those markets a known code share agreement was eliminated following the review in 2009. In Table 5, we present an analysis of these markets in order to evaluate the effect of the elimination of the code share agreements on the airfares. Specifically, we undertake a difference-in-differences estimation, such that those markets without any code share agreements in both time periods are perceived as the control group and the markets where code share agreements were eliminated are the treatment groups.[22] As we control for fixed route effects, we simply add POST dummies that take a value of 1 if a code share agreement existed in 2008 and was eliminated by 2010 and 0 otherwise. Consequently, the POST dummies capture the average change in fare due to the removal of the code share agreement after controlling for all other variables. Specifically, we estimate

$$\begin{aligned}\log\left(Fare_t^{ijk}\right) = {} & \gamma_t + \alpha^i + \alpha_1 Distance_t^i + \alpha_2 GDPC_t^i \\ & + \alpha_3 Legs_t^i + \alpha_4 AdvanceTime_t^i + \alpha_5 dLCC/CH_t^{ik} \\ & + \alpha_6 AirlineScore_t^k + \alpha_7 AllianceDummy_t^k \\ & + \alpha_8 OperatingFrequency_t^{ik} + \alpha_9 HHI_t^i \\ & + \alpha_{10} ClassD1_t + \alpha_{11} ClassB_t + \alpha_{12} ClassF_t \\ & + \alpha_{13} POST : FS0_t^i + \alpha_{14} POST : HB0_t^i \\ & + \alpha_{15} POST : POOL0_t^i + \alpha_{16} POST : ROYAL0_t^i \\ & + \alpha_{17} POST : SB0_t^i + \alpha_{18} dLY_t^i + \sum_{x=1}^{6} \alpha_{x+18} DAY_t^x + \varepsilon_t^{ijk}.\end{aligned} \quad (4)$$

In addition, we explore whether the regulator's actions that resulted in the elimination of 14 of the codeshare agreements were beneficial for consumers in lowering transacted airfares. Accordingly, we estimate a similar equation in which we replace the above mentioned POST dummies with a single POST:CS0 dummy that captures the effect on prices experienced in markets where a codesharing agreement was removed.

The estimations of the parameters in Eq. (4) and the reduced equation including only POST:CS0 are presented in Table 5. The results are consistent with the previous discussion, but also give rise to some additional insights. In line with our earlier result that codesharing agreements are generally associated with higher transacted airfares, we find here that the transacted airfares dropped by less than 1% in markets that have experienced the elimination of the code share agreements. However, this result is only weakly significant and of greater interest is the impact of the codesharing agreement type that is being eliminated.

In the markets where pooling and royalties codeshare agreements were eliminated, airfares dropped by about 2%. However, the elimination of hard block agreements does not reveal a significant change in airfares, whilst the removal of soft block agreements has led to a significant decrease in airfares. Of merit is the insight concerning free sale agreements which were previously shown to decrease fares in the hub-hub markets but in the POST analysis show that prices increase significantly when such agreements are dropped. Furthermore, free sale codeshares appear to induce an implicit rivalry between carriers over the pool of passengers as to which company will be the first to sell tickets. Accordingly, in the markets where these agreements were discontinued, airfares increased by 3.5% on average.

6. Conclusions

Historically, stemming from the 1944 Chicago Convention, bilateral agreements were signed between governments in order to facilitate traffic between two countries. Bermuda style agreements regulate the number of designated airline carriers

[20] The relatively small effect of royalties and pooling agreements is somewhat surprising perhaps, since the former is essentially a monopoly and the latter is the equivalent of an anti-trust alliance in which the two airlines coordinate both their schedules and prices. We speculate that unobserved market characteristics (in the case of royalties) and unobserved carrier characteristics (financial distress in the case of pooling) could have diminished the effect. Indeed, two of the three carriers that had a pooling agreement have since gone bankrupt. Financial difficulties may explain this result as described in Hofer et al. (2005, 2009) in which it is shown that financially distressed airlines tend to reduce their airfares.

[21] Following a suggestion from an anonymous referee of this journal, we also tested marketing carrier fixed effects with broadly similar insights: free sale and soft block are associated with significant reductions in airfares.

[22] Our difference-in-differences estimation is similar to that carried out by Kwoka and Shumilkina (2010), who studied the effect of the USAir-Piedmont merger on prices.

Table 5
Fixed effects regression with POST dummies.

LnFare	Fixed effects: CS dummy	Fixed effects: CS types
legs	−0.0802**	−0.0791**
	(0.00287)	(0.00287)
Advance Time (10^{-3})	−1.647**	−1.643**
	(0.0161)	(0.0161)
GDPC (10^{-6})	27.69**	29.51**
	(0.794)	(0.839)
dLCC/CH	−0.198**	−0.195**
	(0.00517)	(0.00523)
AirlineScore	0.150**	0.152**
	(0.00258)	(0.00262)
alliance	0.0439**	0.0390**
	(0.00411)	(0.00413)
OpFreq	−0.00000540	−0.0000155
	(0.0000316)	(0.0000318)
HHI	0.251**	0.251**
	(0.0180)	(0.0184)
ClassD1	0.358**	0.357**
	(0.00321)	(0.00322)
ClassB	0.570**	0.570**
	(0.00322)	(0.00322)
ClassF	0.383**	0.385**
	(0.00453)	(0.00453)
POST CS0	−0.00713+	
	(0.00409)	
POST POOL0		−0.0209**
		(0.00731)
POST ROYAL0		−0.0195
		(0.0131)
POST FS0		0.0353**
		(0.00593)
POST HB0		−0.00971
		(0.00737)
POST SB0		−0.174**
		(0.0123)
dLY	0.178**	0.176**
	(0.00361)	(0.00364)
2010Dummy	0.0246**	0.0316**
	(0.00364)	(0.00380)
Constant	4.320**	4.252**
	(0.0324)	(0.0340)
N	226950	226950
Adjusted R^2	0.519	0.520

Notes: Standard errors in parentheses are robust; Route fixed effects and day of the week dummies are included.
*$p < 0.05$.
+ $p < 0.10$.
** $p < 0.01$

permitted to operate and the frequency between the two countries, among other elements. A gradual process of liberalization has led to 'open skies' in which carriers, whose "principal place of business and effective control" (Hsu and Chang, 2005) is located in the relevant country are free to enter and exit the international market without constraints on frequency or airfare. However, ownership controls and the failure to permit cabotage freedoms still restrict most skies. Similarly, airlines engage in contracts that permit each other access to their inventory of seats on flights through alliances and codeshares because mergers across countries are not permitted due to ownership controls. The varying levels of agreements signed between governments and the various types of contracts signed between airlines have significant implications both for the service levels provided by airlines, as measured by market level frequency, and the transacted airfares.

Recognizing the magnitude and significance of these relationships are at the core of this research and are highly relevant to the regulation of the international aviation industry. Utilizing a unique opportunity for accessing the different codeshare contracts signed by Israeli airlines with counterparts from other countries, facilitated by the review of these agreements by the Israeli Antitrust Authority (IAA), has granted us exposure to the types of codeshare agreements signed by airlines. Conducting empirical analysis on scheduled flights at the market level and on transacted airfares at the itinerary level, we have uncovered significant relationships. First, considering market level frequency, we find that the liberalization effect is significant and positive and overshadows the codesharing effect, which is nullified when accounting for liberalization. Second, we uncover distinct relationships between the type of codeshare agreements and the airfares paid by passengers over and above the level of liberalization. Royalties, whereby one airline compensates another for operational abstention, are associated with the largest increase in airfares, lending support to the decision of the Israeli Anti-trust Authority to cancel such agreements. Soft block agreements, whereby an airline "borrows" returnable seats from its counterpart, and hard block codeshares, wherein seats are non-returnable, provide mixed results with respect to their impact on airfares. However free sale agreements, wherein access to marketing the other airline's seats is granted if available, show a significant reduction in airfares for the majority of passengers. Overall, the insights clearly indicate that focusing attention on the type of the codesharing contract, rather than the presence of such a contract on a hub-to-hub link, is of major significance to understanding the impact of codesharing agreements on airfares. Thus, our work complements earlier work, such as that of Brueckner and Whalen (2000), by demonstrating the impacts of the type of codesharing agreements and their influence on pricing decisions. Due to the fact that free sale agreements appear to reduce airfares, regulators should consider the type of codeshare when appraising requests for collaboration. For example, a joint venture in which airlines are permitted to pool revenues is likely to lead to higher airfares whereas a free sale agreement may well lower them.

This work sheds light on aspects of collaboration between firms and market regulation that have been overlooked thus far. Following Morrison (1996), additional analysis is required to understand the long term relationships between the agreements discussed in the paper and frequency and pricing, as well as market entry and exit decisions by airlines. Namely, an analysis with a larger panel dataset spanning a longer timeframe is required to assess how liberalization of the skies induces entry by new players and whether this entry is sustainable and overall yields improved services and lower airfares for passengers. Similarly, the regulation of codesharing contracts needs to evaluate the impact on airfares in the longer term as a function of the type of codeshare signed.

Statement of contribution

Code sharing agreements between airlines are confidential contracts and hence the literature has been limited in the exploration of the true effects of the code sharing types on frequencies and airfares. One of the authors was privy to the codeshare agreements as part of an advisory role to the Antitrust Authority. This has allowed us to explore the effect of the different code sharing types—royalties, pooling, hard block, soft block and free sale—on the transacted airfares and the frequencies of flights in the corresponding international markets. Additionally, we capture the effect of the bilateral liberalization agreements signed between governments. The emerging results shed light on the role of liberalization and, importantly, on the impact of the various code sharing agreements on fares. This is of major interest for decision and policy makers as well as regulators in rethinking and designing future aviation policies and approving horizontal

Table A.1
Summary statistics.

Variable	Observations	Mean	Standard deviation
GDPC 2007	38	19,114	17,739
GDPC 2008	38	20,910	18,878
GDPC 2009	38	18,926	17,552
GDPC 2010	38	19,399	17,731
GDPC 2011	38	21,241	19,587
Distance (from Tel Aviv to destination city)	54	3383.82	2580.23
POP 2007	38	104 m	279 m
POP 2008	38	105 m	281 m
POP 2009	38	105 m	284 m
POP 2010	38	106 m	286 m
POP 2011	38	107 m	289 m
Legs	398,149	1.17	0.38
AdvanceTime	398,149	42.36	51.52
Fare (one way)	398,149	466.71	423.85
If distance > 5000	120,554	724.62	504.51
If distance < 5000	277,595	354.70	325.12
If distance < 3000	174,200	316.28	282.13
If distance < 1000	11,133	181.37	76.307
dLY	398,149	0.48	
dLCC/CH	54	0.148148	
AirlineScore	54	2.814815	0.802686
Alliance	54	0.462963	

contracts, and to researchers in understanding the need for further exploration of these issues.

Acknowledgments

We would like to thank Profs. Martin Dresner, David Genesove, David Gillen, Stef Proost and Clifford Winston for useful discussions, and two anonymous reviewers for their helpful and constructive feedback, as well as the participants of the Kuhmo Nectar conference 2012, INFORMS 2012 and 2013, the University of Tokyo, Cologne University and FH Worms. Nicole Adler would like to thank the Israel Science Foundation Grant number 1029-09 and the Recanati Fund for financially supporting this research.

Appendix A

See Appendix Table A.1.

References

Adler, N., Smilowitz, K., 2007. Hub-and-spoke network alliances and mergers: price-location competition in the airline industry. Transp. Res. Part B: Methodol. 41 (4), 394–409.
Adler, N., Hanany, E., 2015. Effects of Inter-firm Agreements: The Case of Airline Codesharing. Working Paper, Hebrew University of Jerusalem, Israel.
Armantier, O., Richard, O., 2006. Evidence on pricing from the Continental Airlines and Northwest Airlines code-share agreement. In: Lee, D. (Ed.), Advances in Airline Economics: Volume 1: Competition Policy and Antitrust. Elsevier Press, Amsterdam.
Armantier, O., Richard, O., 2008. Domestic airline alliances and consumer welfare. RAND J. Econ. 39 (3), 875–904.
Bamberger, B.E., Carlton, D.W., Neumann, L.R., 2004. An empirical investigation of the competitive effects of domestic airline alliances. J. Law Econ. 47, 195–222.
Bilotkach, V., 2005. Price competition between international airline alliances. Journal of Transport Economics and Policy, 167–189.
Bilotkach, V., Gorodnichenko, Y., Talavera, O., 2010. Are airlines' price-setting strategies different? J. Air Transp. Manag. 16, 1–6.
Brueckner, J., 2001. The economics of international codesharing: an analysis of airline alliances. Int. J. Ind. Organ. 19, 1475–1498.
Brueckner, J., 2003. International airfares in the age of alliances: the effects of codesharing and antitrust immunity. Rev. Econ. Stat. 85, 105–118.
Brueckner, J., Lee, D.N., Singer, E.S., 2013. Airline competition and domestic U.S. airfares: a comprehensive reappraisal. Econ. Transp. 2 (1), 1–17.
Brueckner, J., Proost, S., 2010. Carve-outs under airline antitrust immunity. International Journal of Industrial Organization 28 (6), 657–668.
Brueckner, J., Pels, E., 2005. European airline mergers, alliance consolidation, and consumer welfare. Journal of Air Transport Management 11 (1), 27–41.
Brueckner, J., Whalen, T., 2000. The price effects of international airline alliances. J. Law Econ. 43, 503–545.
Chen, Y., Gayle, P.G., 2007. Vertical contracting between airlines: an equilibrium analysis of codeshare alliances. Int. J. Ind. Organ. 25 (5), 1046–1060.
Doganis, R., 2002. Flying Off Course: The Economics of International Airlines, 3rd Edition Routledge, NY.
Dresner, M., Tretheway, M.W., 1992. Modelling and testing the effect of market structure on price: the case of international air transport. J. Transp. Econ. Policy 26 (2), 171–184.
Escobari, D., Gan, L., 2007. Price dispersion under costly capacity and demand uncertainty, NBER Working Paper 13075.
Gayle, P.G., 2007. Airline code-share alliances and their competitive effects. J. Law Econ. 50, 781–819.
Gayle, P.G., 2008. An empirical analysis of the competitive effects of the Delta/Continental/Northwest codeshare alliance. J. Law Econ. 51, 743–766.
Gerlach, M., 2013. Doctoral dissertation. Decentralized Code-Share Revenue Management in Airline Alliances. Freie Universität Berlin.
Gilo, D., Simonelli, F., 2015. The price-increasing effects of domestic code-sharing agreements for non-stop airline routes. Journal of Competition Law and Economics 11 (1), 69–83.
Hanlon, P., 2007. Global airlines: Competition in a transnational industry, 3rd Edition Butterworth-Heinemann, NY.
Hofer, C., Dresner, M., Windle, R., 2005. Financial distress and US airline fares. J. Transp. Econ. Policy 39, 323–340.
Hofer, C., Dresner, M.E., Windle, R.J., 2009. The impact of airline financial distress on US air fares: a contingency approach. Transp. Res. Part E 39, 323–340.
Hsu, C.-J., Chang, Y.-C., 2005. The influences of airline ownership rules on aviation policies and carriers' strategies. Proc. East. Asia Soc. Transp. Stud. 5, 557–569.
Iatrou, K., Oretti, M., 2007. Airline Choices for the Future: From Alliances to Mergers. Ashgate, Aldershot, England.
Ito, H., Lee, D., 2005. Domestic codesharing practices in the US airline industry. J. Air Transp. Manag. 11, 89–97.
Ito, H., Lee, D., 2007. Domestic codesharing, alliances and airfares in the U.S. airline industry. J. Law Econ. 50, 355–380.
Kwoka, J., Shumilkina, E., 2010. The price effect of eliminating potential competition: evidence from an airline merger. J. Ind. Econ. 58 (4), 767–793.
Li, J., Netessine, S., 2011. Partnering with Competitors: Effects of Alliances on Airline Entry and Capacity Decisions. Working Paper, INSEAD, France.
Mantin, B., Koo, B., 2009. Dynamic price dispersion in airline markets. Transp. Res. Part E 45, 1020–1029.
Morrison, B., 1996. Airline mergers: a longer view. J. Transp. Econ. Policy 30 (3), 237–250.
Oum, T.H., Park, J.H., Zhang, A., 1996. The effects of airline codesharing agreements on firm conduct and international airfares. J. Transp. Econ. Policy 30, 187–202.
Park, J., Zhang, A., 2000. An empirical analysis of global airline alliances: cases in North Atlantic markets. Rev. Ind. Organ. 16, 367–384.
Steer Davies, Gleave, 2007. Competition impact of airline code-share agreements. Report Prepared for the European Commission.
Talluri, T., van Ryzin, G.J., 2004. The Theory and Practice of Revenue Management. Springer, New York.
Wan, X., Zou, L., Dresner, M., 2009. Assessing the price effects of airline alliances on parallel routes. Transp. Res. Part E: Logist. Transp. Rev. 45 (4), 627–641.
Whalen, T., 2007. A panel data analysis of code sharing, antitrust immunity and open skies treaties in international aviation markets. Rev. Ind. Organ. 30, 39–61.
Winston, C., Yan, J., 2012. Open Skies Agreements and Air Travelers' Fares: Recent and Prospective Benefits. Brookings Institution, Working Paper.
Wright, C.P., Groenevelt, H., Shumsky, R., 2010. Dynamic revenue management in airline alliances. Transp. Sci. 44, 15–37.
Zhang, A., Zhang, Y., 2006. Rivalry between strategic alliances. International Journal of Industrial Organization 24 (2), 287–301.

Please cite this article as: Adler, N., Mantin, B., Government and company contracts: The effect on service and prices in international airline markets. Economics of Transportation (2015), http://dx.doi.org/10.1016/j.ecotra.2015.05.005